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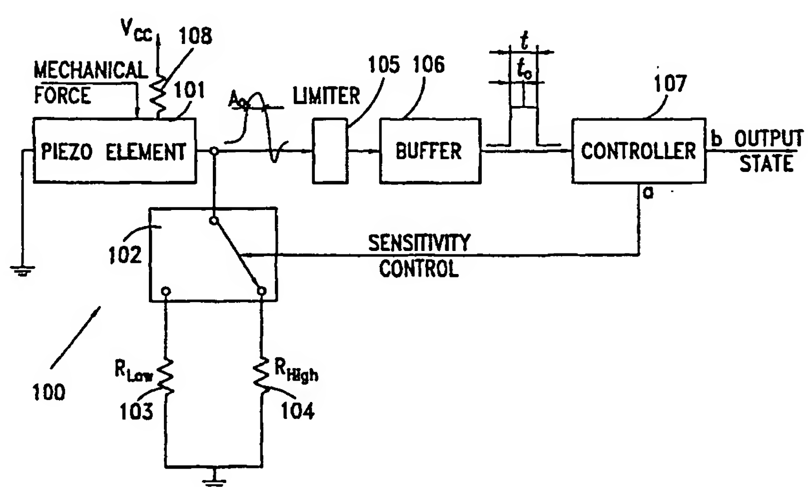
(54) Title: A CONTINUOUS SWITCH EMPLOYING A PRESSURE-SENSITIVE ELEMENT



(57) Abstract: Method and apparatus of producing an activating signal by exerting pressure on a pressure-sensitive element. An electronic circuit is provided, in which the pressure-sensitive element is inserted, that has two modes, a default mode and a transitory mode. The circuit is normally kept in the default mode, in which it generates a primary activating signal, in the same manner and under the same conditions as a conventional pressure-sensitive switch, when an operator produces a primary pulse, having amplitude and duration not below predetermined thresholds, by applying pressure to the pressure-sensitive element. When the primary activating signal has been generated, or concurrently with its generation, the circuit is switched to the transitory mode, in which it generates secondary activating signals, in response to secondary pulses produced by pressures lower than the pressure that has produced the primary pulse. The electronic circuit is returned to its default mode, when no secondary pulses have been produced for a predetermined period of time.

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A CONTINUOUS SWITCH EMPLOYING A PRESSURE-SENSITIVE ELEMENT

Field of the Invention

This invention refers to an improved pressure-sensitive switch which, when depressed by an operator, produces a substantially continuous signal and stops producing it when the operator stops depressing it.

Background of the Invention

Pressure-sensitive switches, such as piezoelectric switches comprise a piezoelectric crystal which, when subjected to pressure, produces a voltage pulse. In piezoelectric switches, the crystal is "hooked" in an electronic circuit which is capable of distinguishing between a pulse intended to produce a desired effect, such as the closure of an electric circuit, from pulses that derive from environmental stimuli, such as random vibrations, and therefore constitute noise. For this purpose, the piezoelectric switch comprises, besides auxiliary means such as means for limiting and shaping the pulse produced by the piezoelectric crystal, means - hereinafter called "buffer" - for evaluating the amplitude and duration of said pulse, and if these are above some thresholds, and therefore the pulse indicates that the operator has exerted a pressure on the switch with the purpose of producing a given effect, passing the pulse to a controller that outputs an activating signal which causes such an effect to be produced, generally through the operation of an electric circuit. Since it is irrelevant, as far as the invention is concerned, what is the said effect (e.g., the production of an acoustic or an optical signal, the actuation of a mechanism, the actuation of an electric or electronic circuit, or the like) this description will not be concerned with anything beyond the production of an activating signal. In conventional piezo switches, only one activating

signal is produced, even if the operator maintains the pressure on the piezoelectric crystal, because such pressure will not produce a pulse above the amplitude and duration threshold and therefore will not pass the buffer to issue an activating signal. This is a considerable drawback of piezoelectric switches. A basic schematic circuit employed in conventional piezo switches is disclosed in Fig. 4 of European Patent Application 0343685. On the hand, the drawback cannot be avoided by lowering the pulse thresholds, because this would cause unwanted production of actuating signals by noise pulses.

To produce a continuous effect with a single activating signal, it might be considered transmitting this latter to a device, which, once actuated, operate continuously. However, such a device would continue to operate after the operator has ceased to depress the piezoelectric switch and would wish its operation to stop.

Another pressure-sensitive element, used to control the operation of electrical circuits, is a pressure-sensor, such as SD series (Thermometrics Inc., New Jersy, USA). The sensor consists of an equivalent resistor bridge, to which an input voltage is applied. The resulting output voltage varies within a predetermined span, according to the level of the applied pressure. The output voltage can be sensed and further processed, so as to convert the applied pressure into required data. However, the equivalent resistance value of this type of pressure-sensor is strongly dependent of the ambient temperature, and therefore it is difficult to obtain reliable inferences, related to real/false operations, from output voltage measurements.

It is a purpose of this invention to provide a pressure-sensitive switch which produces substantially continuous activating signals, as long and only as long as the operator wishes it to produce them.

It is another purpose of this invention to provide such a pressure-sensitive switch which produces activating signals in a succession of such a high frequency that they are perceivable as a continuous signal, as long as the operator maintains pressure on the piezoelectric crystal (hereinafter also briefly designated as "piezo element"), and which ceases to produce the signals when the operator lifts the pressure from the piezoelectric crystal.

It is a further purpose of this invention to provide such a switch, which involves only limited modification of existing piezoelectric switches and of the corresponding circuits.

It is a still further purpose of this invention to provide such a piezoelectric switch that has a volume similar to that of a conventional piezoelectric switch.

It is a still further purpose of this invention to provide such a pressure-sensitive switch that is cost effective.

It is a still further purpose of this invention to provide such a switch that is operated in the same way as a conventional pressure-sensitive switch

and therefore requires no instructions to operators accustomed to conventional switches.

Other purposes and advantages of this invention will appear as the description proceeds.

Summary of the Invention

The present invention comprises a method of producing a signal by exerting pressure on a pressure-sensitive element, such as a piezoelectric crystal, which comprises the steps of:

1 - providing an electronic circuit in which the pressure-sensitive element is inserted, that has two modes, a default mode and a transitory mode;

2 – normally keeping said circuit in the default mode, in which it generates a primary activating signal, in the same manner and under the same conditions as a conventional pressure-sensitive element switch, when an operator produces a primary pulse, having amplitude and duration not below predetermined thresholds, by applying pressure to the pressure-sensitive element (generally by applying it with his finger to a key or button of the switch);

3 – when the primary activating signal has been generated, or concurrently with its generation, switching said circuit to the transitory mode, in which it generates secondary activating signals, in response to secondary pulses produced by pressures lower than the pressure that has produced said primary pulse (generally, produced by vibrations of the operator's finger which continues to apply pressure to the pressure-sensitive element); and

4 – returning the electronic circuit to its default mode, when no secondary pulses have been produced for a predetermined period of time.

Conventional pressure-sensitive switches, such as piezoelectric switches, include an electronic circuit, which produces an activating signal when an activating voltage pulse is produced by the pressure-sensitive element of the switch. Such switches also include a derivation of said circuit, which can be schematized as a connection of the pressure-sensitive element to the ground. Since said derivation competes with the electronic circuit – so to speak – for the voltage produced by the pressure-sensitive element, its resistance determines the amplitude of voltage pulse received by the electronic circuit in response to a given pressure exerted on the pressure-sensitive element, and therefore determines what pressure on the pressure-sensitive element is required for it to generate an activating pulse. Therefore said resistance must be such that deliberate actuation of the switch on the part of an operator will produce an activating pulse, but pulses produced by random environmental stimuli will be perceived as noise and not passed to the activating signal generating controller.

Preferably, according to the invention, the aforesaid amplitude threshold apply to the secondary pulses as well. However, the pressures which produce the secondary pulses are lower than the pressure that has produced the primary pulse. In order that different pressures should produce pulses that reach the same amplitude threshold, the switch of the invention includes a derivation similar to that of the conventional switches, but having at least two alternative resistances; and is switched

from the default to the transitory mode and vice versa by changing from one to the other of said resistances, whereby to change the value of the pressure on the pressure-sensitive element that is sufficient to generate an activating pulse. When the higher resistance is selected and the sensitivity of the pressure-sensitive element is increased, only the amplitude threshold level applies, independent of duration conditioning, until the applied finger pressure is released.

More specifically, the method of the invention comprises:

a - providing an electronic circuit, to which the pressure-sensitive element is connected, and a derivation thereof having a normal higher resistance and an alternative lower resistance;

b - setting amplitude and duration thresholds that must be at least equaled for a pulse to be an activating pulse;

c - when a voltage pulse is produced by an operator by exerting a pressure on the pressure-sensitive element, limiting and shaping said pulse;

d - sensing the amplitude and duration of said shaped pulse;

e - if said amplitude and duration are above the predetermined thresholds, producing an activating signal;

f - concurrently, switching the electronic circuit of the pressure-sensitive switch from the default to the transitory mode by changing the resistance of said derivation from said lower to said higher value;

g - for each additional pulse above said amplitude threshold, generating an activating signal; and

h – when no further pulses above said amplitude threshold is sensed for a time exceeding a predetermined duration, returning the resistance of said derivation to its lower value.

It is known that when a person exerts a pressure on a surface, which in this case is the outer surface of the pressure-sensitive switch, by a finger, a vibratory oscillation of the pressure is produced, even though the person exerting it is not aware of it and feels that he is exerting a constant pressure. These oscillations are reflected in pulses produced by the pressure-sensitive element. However, said pulses have very low amplitudes and in conventional pressure-sensitive switches are sensed as noise and generate no activating signals. This is a necessary feature of pressure-sensitive switches, because if vibratory pressures of the kind which are unconsciously produced by a person pressing a switch were sufficient to generate activating signals, such signals would also be randomly generated by random vibrations and other environmental stimuli. In order to prevent the noise from activating the switch, the design is such that first, a relatively strong signal should be generated by the finger, and then, the switch is held active by the finger vibrations. This can be currently achieved as shown in Fig. 1, hereinafter described.

According to the invention, an apparatus is provided which includes all the elements of a normal pressure-sensitive switch, but in addition comprises means for changing the switch from a default mode to a temporary mode and vice versa. These means must be such that as long as the switch is in the default mode, only the deliberate actuation thereof by a pressure exerted by an operator on the pressure-sensitive element will

produce a primary activating pulse; that once such a pulse has been detected and the primary activating pulse has been produced, the switch is passed to the transitory mode, in which the vibrations of an operator's finger are sufficient to produce secondary activating pulses; and once a predetermined time has passed without any activating pulses' being detected, the switch returns to the default mode. The means for passing from the default mode to the transitory mode preferably comprise providing a high and a low resistance in parallel in the derivation (typically a connection to the ground) of the electronic circuit of the switch; normally keeping the low resistance inserted in said derivation; inserting the high resistance in place of the low one to pass from the default to the transitory mode; and re-inserting the low resistance to return from the transitory to the default mode. The exchange of one of said resistances for the other is effected by the controller of the switch circuit when it receives the primary activating pulse and when it detects that the aforesaid predetermined time has passed without the production of secondary activating pulses. Instead of changing from one resistance to another, the low resistance could remain constantly inserted and an additional resistance be inserted to switch from the default to the provisional mode and disinserted to return to the default mode, the sum of the low and the additional resistances constituting the high resistance.

Brief Description of the Drawings

In the drawings:

- Fig. 1 is a block diagram of a continuous activating switch electronic circuit, employing a pressure-sensitive element as an interface to the operator, according to a preferred embodiment of the invention;

- Fig. 2 is a schematic diagram of an electric circuit for implementing a continuous activating switch electronic circuit, employing a piezoelectric element as an interface to the operator, according to a preferred embodiment of the invention; and
- Figs. 3A and 3B schematically illustrate the voltage of the response signal, at lower and at higher sensitivities, respectively.

Detailed Description of Preferred Embodiments

Fig. 1 is a block diagram of a continuous activating switch electronic circuit, employing a pressure-sensitive element, such as a piezoelectric element as an interface to the operator, according to a preferred embodiment of the invention. The circuit 100 consists of a piezoelectric element 101 (or another pressure sensitive element, also denoted by the same numeral 101, which changes its electrical properties and/or mode of operation, in response to applied pressure), normally contained in a mechanical housing, which converts the mechanical pressure applied by the operator, to an electric response signal. The magnitude of the electric response signal provided by the piezoelectric element 101 is determined by the equivalent resistance which is seen in parallel to the element 101. In this example, the term equivalent resistance means the total resistance that is connected between one port of the element 101 and ground (or other defined common point), when the other port is connected to ground (or to the other defined common point). An electronic selector 102 is connected between one contact of the element 101, and a pair of resistors, 103 and 104, which are connected to the other contact of the element 101. The series combination of the selector and one of the selected resistors constitutes the parallel equivalent resistance, which limits the magnitude

of the response signal. Since the energy contained in the response signal is limited, lower equivalent resistance consumes more energy, which results in a lower magnitude of the response signal.

The resistance of the resistor 103 is significantly lower than the resistance of the resistor 104, and therefore the sensitivity of the response of the element 101 to applied mechanical force is varied according to the selection made by the selector 102. The response signal enters a limiter circuitry 105, which limits the magnitude of the response signal and keeps it below a safe level threshold. The limiting threshold of the limiter 105 is determined by the maximum ratings of the other components in the circuit 100 which are sensitive, so as to protect them against failures. Response signals, which are below the threshold level, are transferred by the limiter 105 without affecting their magnitude. Response signals, which are above the threshold level, are "chopped" and transferred by the limiter 105 with a reduced magnitude. The output of the limiter 105 is connected to a buffer circuit 106, which converts the analogue response signal arriving from the element 101 into a logical pulse, which varies between two discrete levels (normally between a "1" logic level and "0" logic level). One discrete level (normally the higher "1" level) corresponds to an activated mode of circuit 100, while the other mode (normally the lower "0" level) corresponds to a disactivated mode of circuit 100. If the magnitude of the logical pulse exceeds a predetermined threshold level A_0, the buffer 106 provides a higher level pulse (normally "1" logic) having a duration which corresponds to the time period that the magnitude is greater than the threshold level. If not, the buffer 106 provides a lower

level pulse (normally "0" logic). The logical pulse is fed into a programmable controller 107, which is connected via a control output *a* to the control input of the selector 102. The logic level and the duration *t* of the logical pulse are used by the programmable controller 107 to identify actual mechanical pressure applied by the operator, and in response to such mechanical pressure, to increase the sensitivity of the element 101 to applied mechanical force. Sensitivity is increased by controlling the selection of the selector 102 to connect the contact of element 101 to ground via the higher resistor 104. When operating in high sensitivity mode, continuous force which is applied on the element 101 by the operator, provides a response signal which has a magnitude (greater than A_0) which is sufficient to keep the duration of the logical pulse provided by the buffer 106 in the proper logical state, so as to drive the controller into an activated mode. In response, the output *b* of the controller 107 is switched into a predetermined logical state, which is fed into a following circuit and activates it.

According to a preferred embodiment of the invention, a default state is determined by pre-programming the controller 107 to control the selector 102 to select first the lower resistor 103. As a result, the sensitivity of the element 101 is decreased, and only relatively high mechanical pressure causes the element 101 to generate a response pulse which is sufficient to drive the buffer 106 to provide a "1" state pulse. The sensitivity is decreased to eliminate false operation of the circuit 100 those results from noise or other unwanted mechanical vibrations, such as mechanical impacts in the vicinity of the piezoelectric element 101. The controller 107

is also programmed with a threshold duration t_0, which is used to identify false impacts on the element 101. Typically, in response to such false impacts, as well as to noise, the element 101 provides a response pulse having amplitude which is above the threshold A_0 only for a relatively short duration t ($t<t_0 \approx 10$ mS). Therefore, two conditions are established for eliminating false operation: a) the magnitude of the response pulse should be greater than A_0; and b) the duration of the corresponding logical pulse provided by the buffer 106 should be at least t_0. The controller 107 measures the duration t_0 of the logical pulse and only if $t>t_0$ the controller switches the selection of the selector 102 to resistor 104 (i.e., higher sensitivity). During the measurement time, the output b of the controller 107 is kept in its disactivated state. After the two conditions are fulfilled, the controller 107 switches the selector 102 to high sensitivity mode (by selecting the higher resistor 104), and from that time the element 101 continuously senses the mechanical pressure that is applied by the operator. Assuming that the operator continuously depresses the housing of the piezoelectric element 101, vibratory mechanical force is applied on the element 101, because a human hand inherently vibrates when applying a muscular force, such as pressing a button. This vibrations are detected by the element 101 and a relatively strong response signal (of amplitude greater than A_0) is generated, due to its high sensitivity. Therefore, the buffer 106 keep providing a continuous "1" state pulse, as long as the operator continues to put (hand) pressure on the element 101. The controller, in response, the controller 107 keeps the output b in its activating logical state.

On the other hand, when the operator wishes to stop activating the circuit 100, he releases his hand pressure, and therefore, no vibrations are applied on the housing of the element 101. In response, no analogue response signal arrives from the element 101, and the logical pulse at the output of the buffer 106 switches discrete level (normally the lower "0" level) which corresponds to a disactivated mode of circuit 100. The controller 107 is pre-programmed to switch back to the default mode after being in the disactivated mode, so as to enable a new operation.

According to a preferred embodiment of the invention, a pressure-sensitive element, such as an SD or an SP series silicon pressure-sensor (Thermometrics Inc., New Jersy, USA) may be used, rather than the piezoelectric element 101 (shown in Fig.1 above). The pressure-sensitive element 101 may be a resistor bridge, to which an external input voltage Vcc is applied from a power supply via a resistor 108, which determines the current flowing through the bridge. The balance of the bridge, and/or the equivalent resistance of one or more resistors of the bridge, is varied in response to mechanical pressure applied to the housing containing the bridge resistors. The input voltage is converted by the bridge resistors into an output voltage, the amplitude of which is determined by the value of these resistors, and hence, by the applied pressure. Therefore, the operation of such pressure-sensitive element is essentially equivalent to the operation of a piezoelectric element.

Alternatively, a single resistor, which is sensitive to the applied pressure, may be used as the pressure-sensitive element. The resistor may be

connected in series with the resistor 108, thereby determining the current flowing from the power supply to ground. Therefore, output voltage taken from the common port of these resistors (i.e., a voltage divider) is sensitive to the applied pressure. The sensitivity may be controlled by the ratio between the resistance values of the resistors. The fact that the equivalent resistance value of this type of pressure-sensor may be strongly dependent on the ambient temperature, does not affect the operation of such pressure-sensitive elements, since the circuit 100 is sensitive to changes in the resulting output voltage (derived from changes in the resistance value in response to finger vibrations) and is not sensitive to the absolute value of the resulting output voltage.

Fig. 2 is a schematic diagram of an electric circuit for implementing a continuous activating switch electronic circuit, employing a piezoelectric element as an interface to the operator, according to a preferred embodiment of the invention. The circuit 200 comprises a piezoelectric element Y1 having one contact connected to ground, and the other contact c connected to a resistor R4, which together with the zener diode DZ6 constitutes the limiter 105. The element Y1 outputs a voltage level, which is, determined by the equivalent resistance, which appears in parallel with the element Y1. The zener diode DZ6 limits the voltage at point d to its zener voltage Vz. If the voltage Vc at point c is greater than the zener voltage Vz, current flows from point c to ground via the resistor R4 and the zener diode DZ6, which stabilizes the voltage at point d to Vz, which is safe for the operation of circuit 200. If the voltage at point c is lower than the zener voltage Vz no current flows through R4 and therefore Vc=Vd.

The buffer 106 consists of the FET Q2 and the resistor R2. When the voltage Vd is very low (no operation) the FET Q2 is in cutoff (not conducting) and therefore, no current flows through the resistor R2. The output voltage Ve of the buffer is the power supply voltage, Vdd (normally selected to be +5 Volts, which is equivalent to "1" logic). When the voltage Vd is relatively high (i.e., the operator depresses the element Y1) the FET Q2 is in saturation (conducting) and therefore, high current flows through the resistor R2, and the output voltage Ve of the buffer is essentially zero (ground). The output voltage Ve is input into the input of the controller U1, which controls an internal FET Q1 that is connected between ground and the input f of the controller U1. A resistor R5 is connected between the point c and the input f, and is part of the equivalent resistance, which appears in parallel with the element Y1. Q1 provides a virtual connection of the input f to ground, trough two extreme resistance values (few Ohms or hundreds of Mega-Ohms), according to a corresponding control signal provided to its gate. The control signal is provided by the controller U1 according to the level of the logic state Ve. At the default (low sensitivity) mode, the controller U1 is programmed to drive Q1 into saturation, thereby connecting R5 to ground via very low resistance. In addition, the output b is disabled by the controller U1 during the default mode, so as to prevent activation while t_0 is measured. Therefore, at this mode the sensitivity of the element Y1 is lower. On the other hand, if the actual mechanical pressure (applied by the operator) is identified, the controller first drives the FET Q1 into cutoff and increases the sensitivity of the element Y1. At this mode, R5 is connected to ground via the large resistance of the FET Q1, and therefore the equivalent resistance which

appears in parallel with Y1 is large. After switching to high sensitivity mode, the input g is continuously monitored by the controller U1, and the output *b* of the controller U1 is switched into a predetermined logical state which is fed into a following circuit and activates it, as long as the pulse level Ve indicates identified human hand vibrations ("1" logical state). When Ve falls to "0" (no vibrations), the output *b* of the controller U1 is switched back into the default (disactivating) state.

Figs. 3A and 3B schematically illustrate the voltage of the response signal, at lower and at higher sensitivities, respectively. At lower sensitivity, application of a relatively strong and continuous pressure on the element Y1, results in an analogue pulse with relatively strong amplitude (over A_0) and limited duration (shorter than t_0), as shown in Fig. 3A. Fig. 3B shows the same effect, but with switching to higher sensitivity at time point t_1. The resulting voltage of the response signal is kept over the level A_0 as long as a continuous pressure is applied on the element Y1 by the operator (i.e., until the time point t_2).

The above examples and description have of course been provided only for the purpose of illustrations, and are not intended to limit the invention in any way. As will be appreciated by the skilled person, the invention can be carried out in a great variety of ways, such as using other elements and/or materials which vary their electric properties in response to applied pressure, employing more than one technique from those described above, all without exceeding the scope of the invention.

CLAIMS

1. Method of producing an activating signal by exerting pressure on a pressure-sensitive element, which comprises the steps of:

1 - providing an electronic circuit in which said pressure-sensitive element is inserted, that has two modes, a default mode and a transitory mode;

2 – normally keeping said circuit in the default mode, in which it generates a primary activating signal, in the same manner and under the same conditions as a conventional pressure-sensitive switch, when an operator produces a primary pulse, having amplitude and duration not below predetermined thresholds, by applying pressure to the pressure-sensitive element;

3 – when the primary activating signal has been generated, or concurrently with its generation, switching said circuit to the transitory mode, in which it generates secondary activating signals, in response to secondary pulses produced by pressures lower than the pressure that has produced said primary pulse; and

4 – returning the electronic circuit to its default mode, when no secondary pulses have been produced for a predetermined period of time.

2. Method according to claim 1, wherein the pressure which produces the primary activating signal is the pressure of an operator's finger on the pressure-sensitive element and the pressures which produce the secondary activating signals are generated by vibrations of the operator's finger which continues to apply pressure to the pressure-sensitive element.

3. Method according to claim 1, comprising providing the switch of a derivation to its electronic circuit and passing it from the default to the transitory mode and vice versa by changing increasing and respectively decreasing the resistance of said derivation.

4. Method according to claim 1, which comprises:

a - providing an electronic circuit, to which the pressure-sensitive element is connected, and a derivation thereof having a normal higher resistance and an alternative lower resistance;

b - setting amplitude and duration thresholds that must be at least equaled for a pulse to be an activating pulse;

c - when a voltage pulse is produced by an operator by exerting a pressure on the pressure-sensitive element, limiting and shaping said pulse;

d - sensing the amplitude and duration of said shaped pulse;

e - if said amplitude and duration are not below the predetermined thresholds, producing an activating signal;

f - concurrently, switching the electronic circuit of the switch from the default to the transitory mode by changing the resistance of said derivation from said lower to said higher value;

g - for each additional pulse above said amplitude threshold, generating an activating signal; and

h – when no further pulses above said amplitude threshold is sensed for a time exceeding a predetermined duration, returning the resistance of said derivation to its lower value.

5. Method according to any one of claims 1 to 4, wherein the pressure-sensitive element is a piezoelectric crystal.

6. Method according to any one of claims 1 to 4, wherein the pressure-sensitive switch is a piezoelectric switch.

7. Method according to any one of claims 1 to 4, wherein the pressure-sensitive element is a pressure-sensitive resistive combination operating with an applied input voltage, said combination varying its electrical characteristics in response to pressure applied thereon.

8. Method according to claim 7, wherein the pressure-sensitive resistive combination forms a resistor bridge.

9. Method according to claim 7, wherein the pressure-sensitive resistive combination is a pressure-sensitive resistor.

10. Pressure-sensitive switch apparatus, which comprises all the elements of a conventional pressure-sensitive switch, and further comprises means for changing the switch from a default mode to a temporary mode and vice versa.

11. Apparatus according to claim 10, wherein the means for changing the switch from a default mode to a temporary mode and vice versa are such that, as long as the switch is in the default mode, only the deliberate actuation thereof by a pressure exerted by an operator on the

pressure-sensitive element will produce a primary activating pulse; that once such a pulse has been detected and the primary activating pulse has been produced, the switch is passed to the transitory mode, in which the vibrations of an operator's finger are sufficient to produce secondary activating pulses; and once a predetermined time has passed without any activating pulses' being detected, the switch returns to the default mode.

12. Apparatus according to claim 11, wherein the means for passing from the default mode to the transitory mode comprise a high and a low resistance in parallel in the derivation of the electronic circuit of the switch, the low resistance being normally inserted in said derivation; means for inserting the high resistance in place of the low one to pass from the default to the transitory mode; and means for re-inserting the low resistance to return from the transitory to the default mode.

13. Apparatus according to claim 12, wherein the switch comprises a controller and the means for passing from the default mode are embodied in said controller, which is programmed to exchange the high resistance for the low one when it receives the primary activating pulse and to reverse said exchange when it detects that a predetermined time has passed without the production of secondary activating pulses.

14. Apparatus according to claim 12, wherein the low resistance is permanently inserted in the derivation of the electronic circuit and an additional resistance is provided to be inserted to pass the switch from the default to the provisional mode and disinserted to return to the default

mode, the sum of the low and the additional resistances constituting the high resistance.

15. Apparatus according to any one of claims 11 to 14, in which the pressure-sensitive element is a piezoelectric crystal.

16. Apparatus according to any one of claims 11 to 14, in which the pressure-sensitive switch is a piezoelectric switch.

17. Apparatus according to any one of claims 11 to 14, in which the pressure-sensitive element is a pressure-sensitive resistive combination operating with an applied input voltage, said combination varying its electrical characteristics in response to pressure applied thereon.

18. Apparatus according to claim 17, in which the pressure-sensitive resistive combination forms a resistor bridge.

19. Apparatus according to claim 17, in which the pressure-sensitive resistive combination is a pressure-sensitive resistor.

20. Method of producing an activating signal by exerting pressure on a pressure-sensitive element, substantially as described and illustrated.

21. Pressure-sensitive switch apparatus, substantially as described and illustrated.

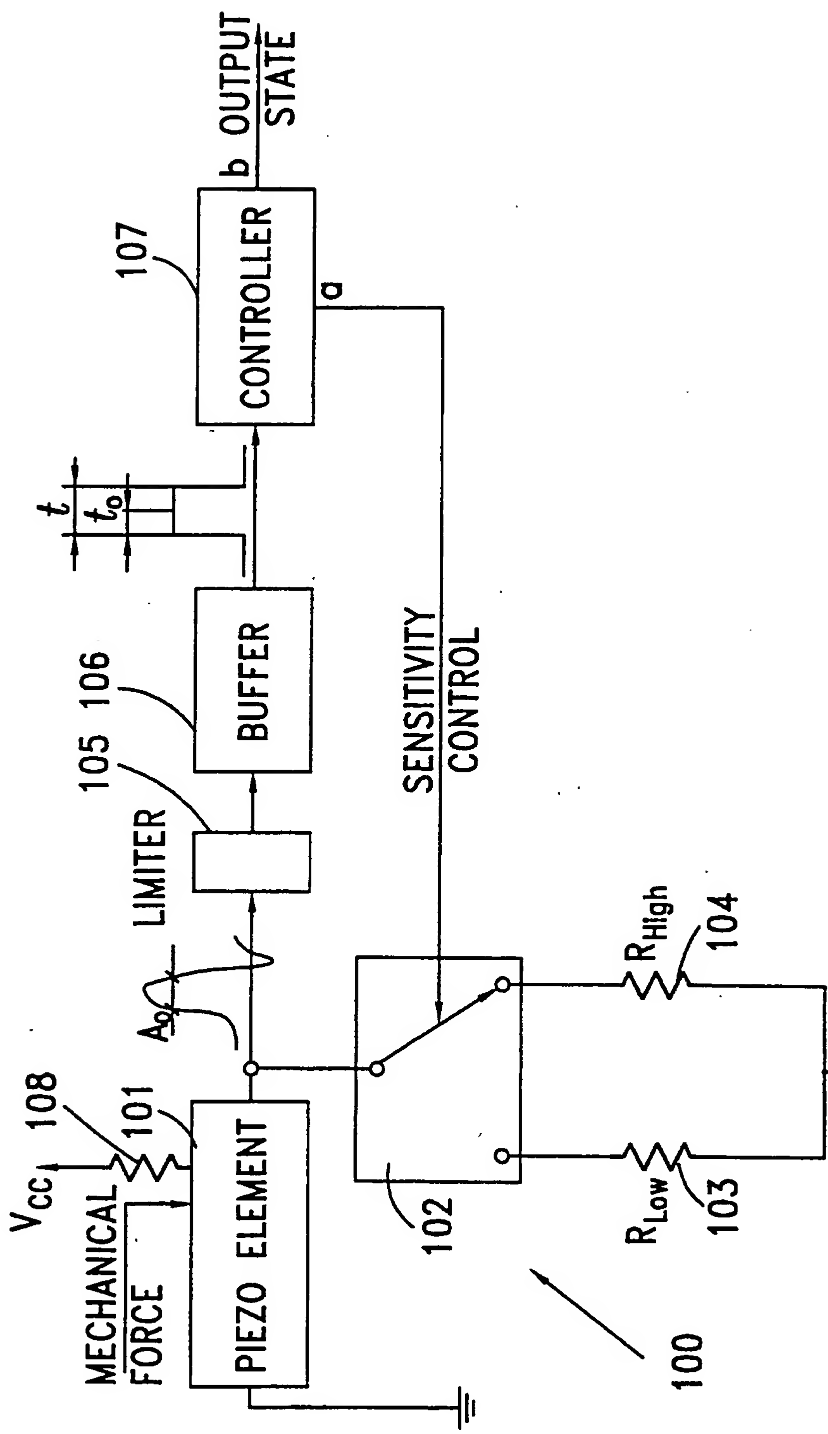
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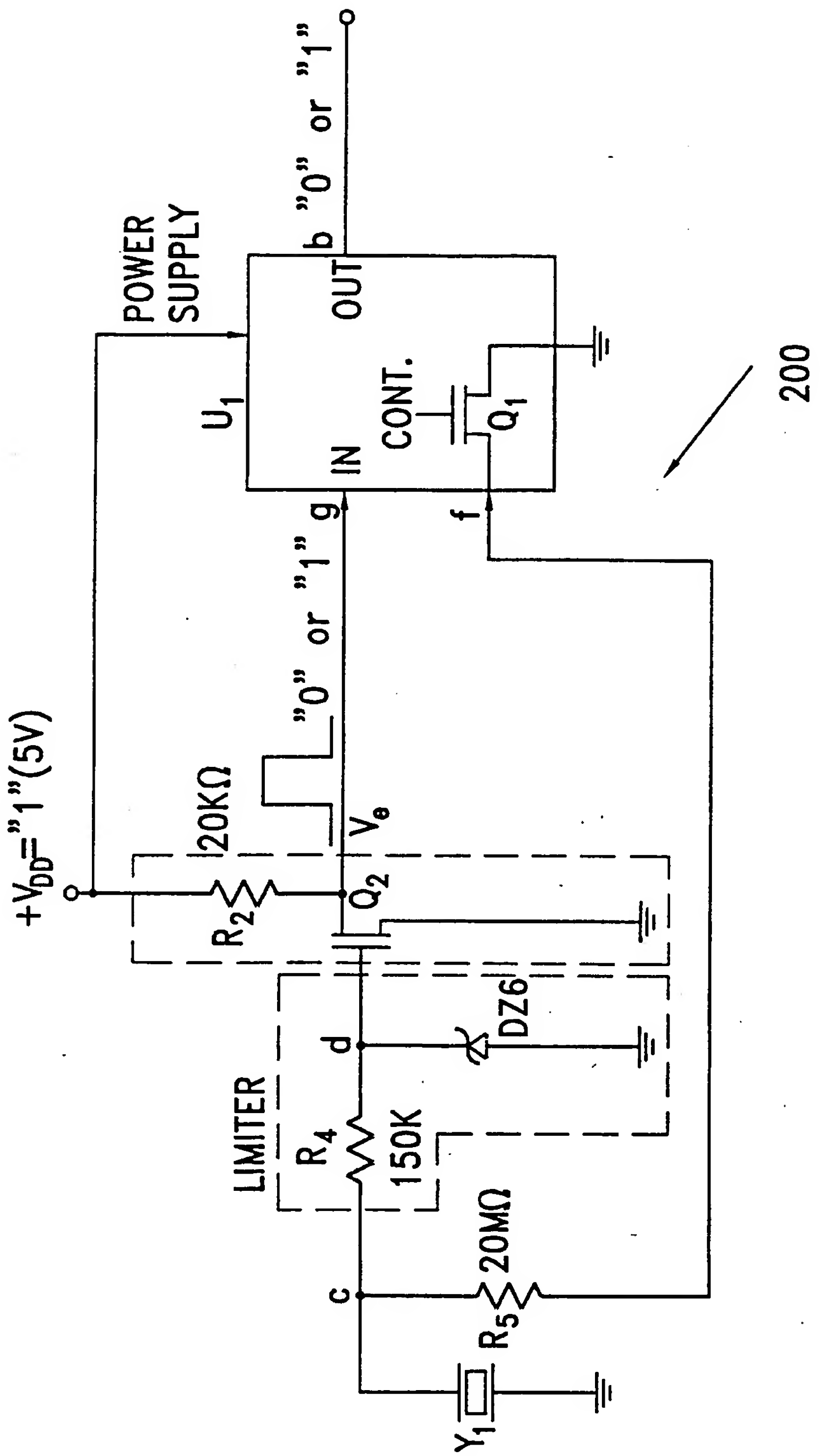
Fig. 1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Q2
Ve
DZ6
d
LIMITER
R4
150K
20MΩ
c
R5
Y1

Fig. 2

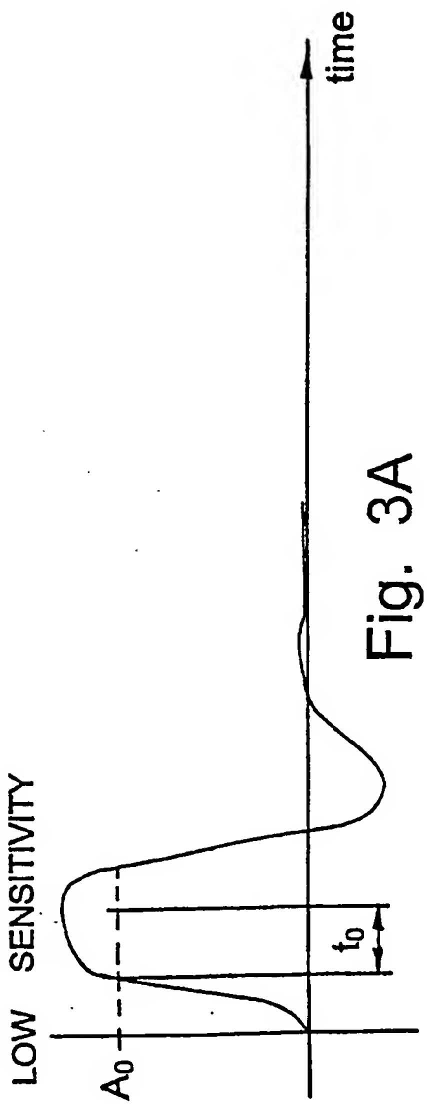

Fig. 3A

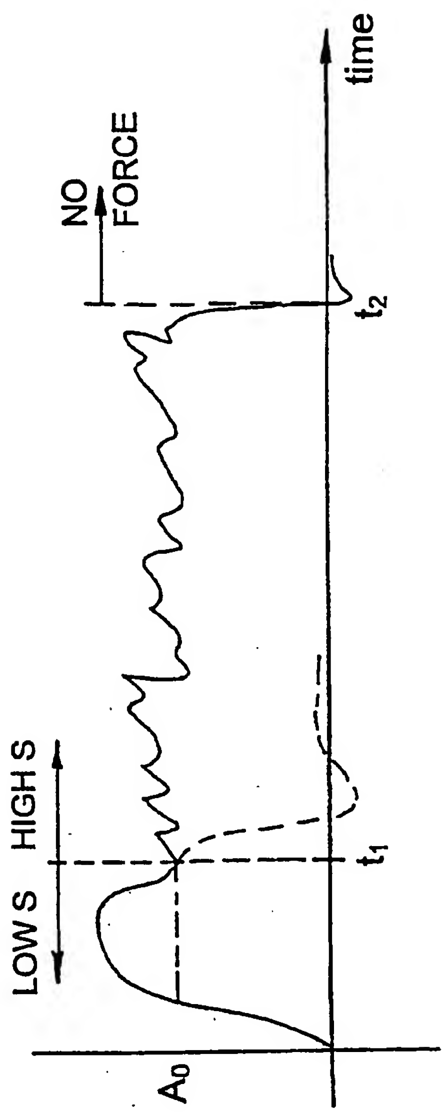

Fig. 3B

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IL 00/00577

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H03K17/96 H01H57/00 H01L41/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H03K H01H H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 295 486 A (HAYWARD GILBERT OSBORNE) 29 May 1996 (1996-05-29) page 2, line 14 -page 5, line 18; figures 1-3	1-21
A	US 5 442 150 A (IPCINSKI RALPH G) 15 August 1995 (1995-08-15) column 4, line 37 -column 5, line 7; figures 19,20 column 6, line 37 -column 6, line 63; figure 35	1-21
A	EP 0 553 881 A (ESSEX ELECTRONICS INC) 4 August 1993 (1993-08-04) column 3, line 4 -column 7, line 3; figures 1-5	1-21

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 February 2001	20/02/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Bergado Colina, J

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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